(NASA-CR-154785) MSSR/MEM COMMONALITY (Bellcomm, Inc.) 7 p

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SUBJECT: MSSR/MEM Commonality
Case 233

DATE: July 19, 1967

FROM: D. E. Cassidy
H. S. London

ABSTRACT

It may be possible to use a vehicle designed for unmanned Mars surface sample return to land a man on Mars and return him to an orbiting spacecraft. This potential exists, despite much heavier payload and lower g limit requirements, because of lower velocities associated with capture orbits at Mars as compared to unmanned surface sample return on a twilight Mars flyby.

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BELLCOMM, INC.

SUBJECT: MSSR/MEM Commonality
Case 103-2

DATE: July 19, 1967

FROM: D. E. Cassidy
H. S. London

MEMORANDUM FOR FILE

It may be possible to use a vehicle designed for unmanned Mars surface sample return to land a man on Mars and return him to an orbiting spacecraft. This potential exists, despite much heavier payload and lower g limit requirements, because of lower velocities associated with capture orbits at Mars as compared to unmanned surface sample return on a twilight Mars flyby.

This is indicated in the tabulation of velocities in the following table:

MISSION	MARS ENTRY VELOCITY	ASCENT ΔV
Mars Twilight		
Flyby - 1975	32,500 fps	36,000 fps
1977	34,500	38,000
1979	39,000	42,500
Manned Mars		
Capture - 1978 Venus Swingby 1982 " " 1984 Direct 1985 Venus Swingby 1986 Direct	20,000 - 25,000 fps (direct entry from hyper-bolic appro-ach)	18,000 fps (rendezvous in one-day period park-ing orbit)

Payloads

A typical payload-ascent velocity tradeoff is shown in Figure 1, assuming a two-stage ascent vehicle with I_{sp} = 375 sec. and λ = .88 for both stages. Gross weight at separation from the manned spacecraft is 15,000 lbs. Figure 1 shows that this vehicle can return a useful load of 80 lbs. to hyperbolic rendezvous in a 1975 twilight flyby mission, or more than 900 lbs. to an elliptical rendezvous orbit of approximately one day period.

[redacted]

These useful loads should be adequate for a MSSR mission and a one-man lander mission respectively. Bellcomm studies indicate that it should be possible to develop a one-man capsule with life support for the short time required which weighs perhaps as little as 600 lbs. Logistics support and experiment payload for longer surface stay time would be landed in a separate vehicle (approximately 5,500 lbs. landed payload with the same entry capsule). To have a second man on the surface would require landing another vehicle.

Alternately, rather than trying to use a small vehicle sized for an MSSR mission as a manned MEM (requiring surface rendezvous with a logistics vehicle and possibly another manned lander), the opposite approach could be taken. A MEM with a completely self-contained manned capsule which supports, e.g., two men for thirty days and which carries the science/engineering payload would probably gross 40,000 lbs. or more. This could be used as an unmanned surface sample return vehicle on earlier manned flyby missions; both the landed science payload which is left on the surface and the returned sample could then be much larger than with a small MSSR vehicle.

Entry Considerations

The MSSR as currently conceived follows a ballistic path ($L/D = 0$) with a ballistic parameter (M/C_DA) = .8 slugs/ft^2. The entry velocity, on the order of 32,000 ft. per second, results from the characteristics of the manned Mars 1975 twilight flyby mission under study by NASA.

The maximum deceleration during entry depends on the entry corridor, as can be seen from the solid curves in Figure 2; and, in the case of the MSSR, nominal design is approximately 40 times earth gravity ($40g_{\oplus}$). For the same corridor capability, however, lower velocities result in lower $g_{\oplus}$'s. At velocities associated with orbital entry, then, the MSSR can achieve entry and not exceed $10g_{\oplus}$'s. This is significant, since, as a first cut, manned entry can be considered if decelerations can be kept within $10g_{\oplus}$.

The use of the MSSR as a manned entry system, then would be restricted to out-of-orbit applications when trimmed to a zero angle-of-attack ($L/D = 0$). Direct entry could be achieved, however, with the MSSR trimmed to an angle-of-attack as illustrated by the dashed lines on Figure 2.

With the MSSR trimmed to an L/D = .45, direct entry can be considered up to a velocity of 22,000 fps for the same entry corridor criteria used for the non-lifting MSSR. Since the modus operandi of an unmanned ballistic entry and a manned lifting entry would be different, the corridor for the manned vehicle could be pushed closer to the overshoot to where a velocity of 25,000 fps is feasible. For the ballistic case, entry near the overshoot results in large range dispersions, and it is therefore desirable to back off somewhat. The manned lifting vehicle, on the otherhand, has substantial ranging capability provided its position in the corridor is reasonably well known at entry.

Conclusions

It may be possible to use essentially the same vehicle for both unmanned surface sample return from Mars to a manned flyby spacecraft and for a manned landing excursion module deployed from a manned spacecraft in orbit around Mars. This could be done either by; (a) using a vehicle designed for the "conventional" MEM mission; this would double in earlier missions as a very large payload MSSR vehicle, or (b) the MEM mission would be carried out by one or more small MSSR's (per the JAG studies), each landing and returning one man. In the latter case, logistics support would be provided by another landing vehicle, so that surface rendezvous would be required for a full-duration surface stay.

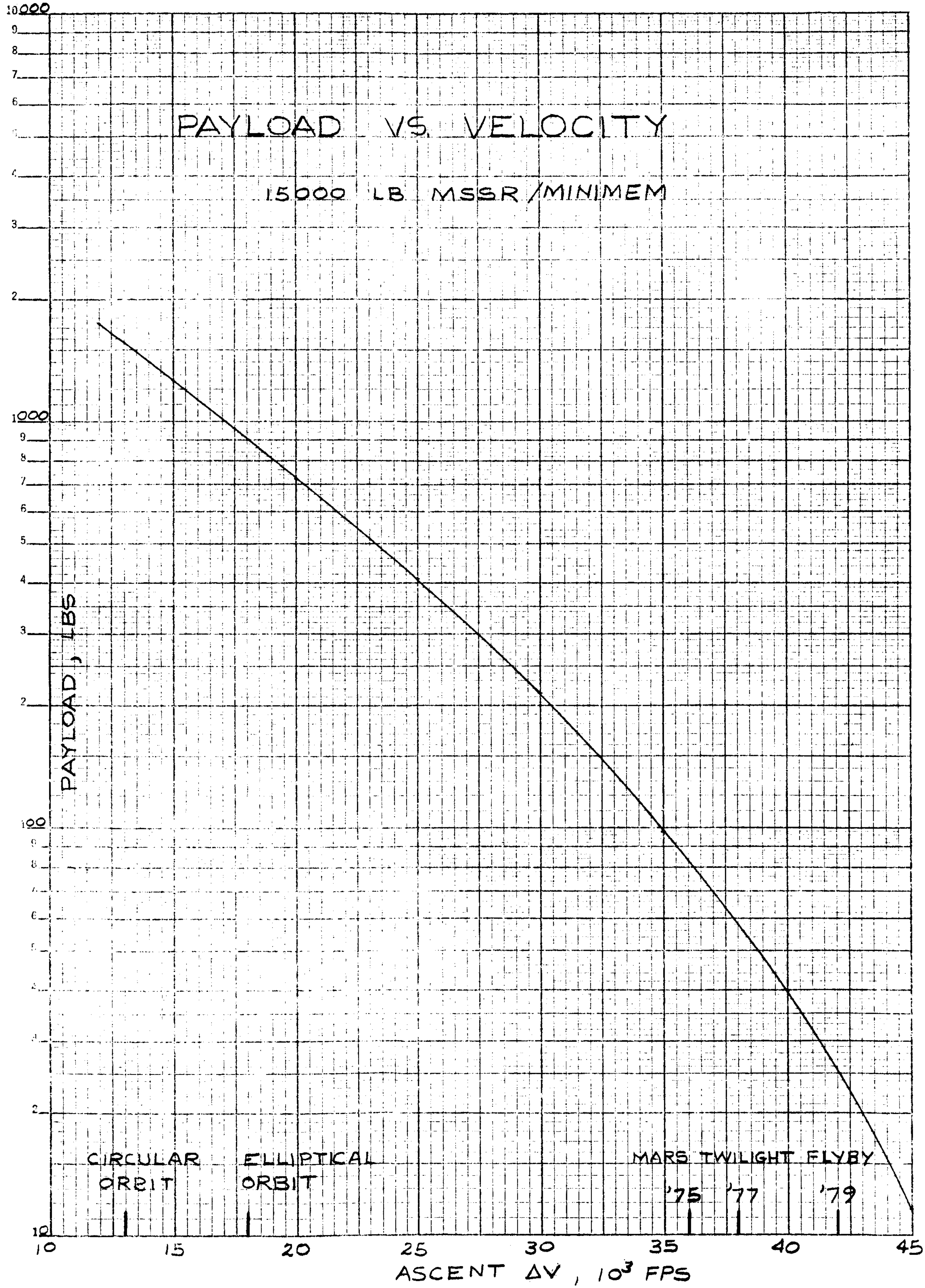
In case (b), the MSSR must be sized for the Mars twilight flyby velocity requirements; commonality would not be possible if it were sized only for the multi-planet flyby missions which have much lower passage velocities at Mars.

D. E. Cassidy

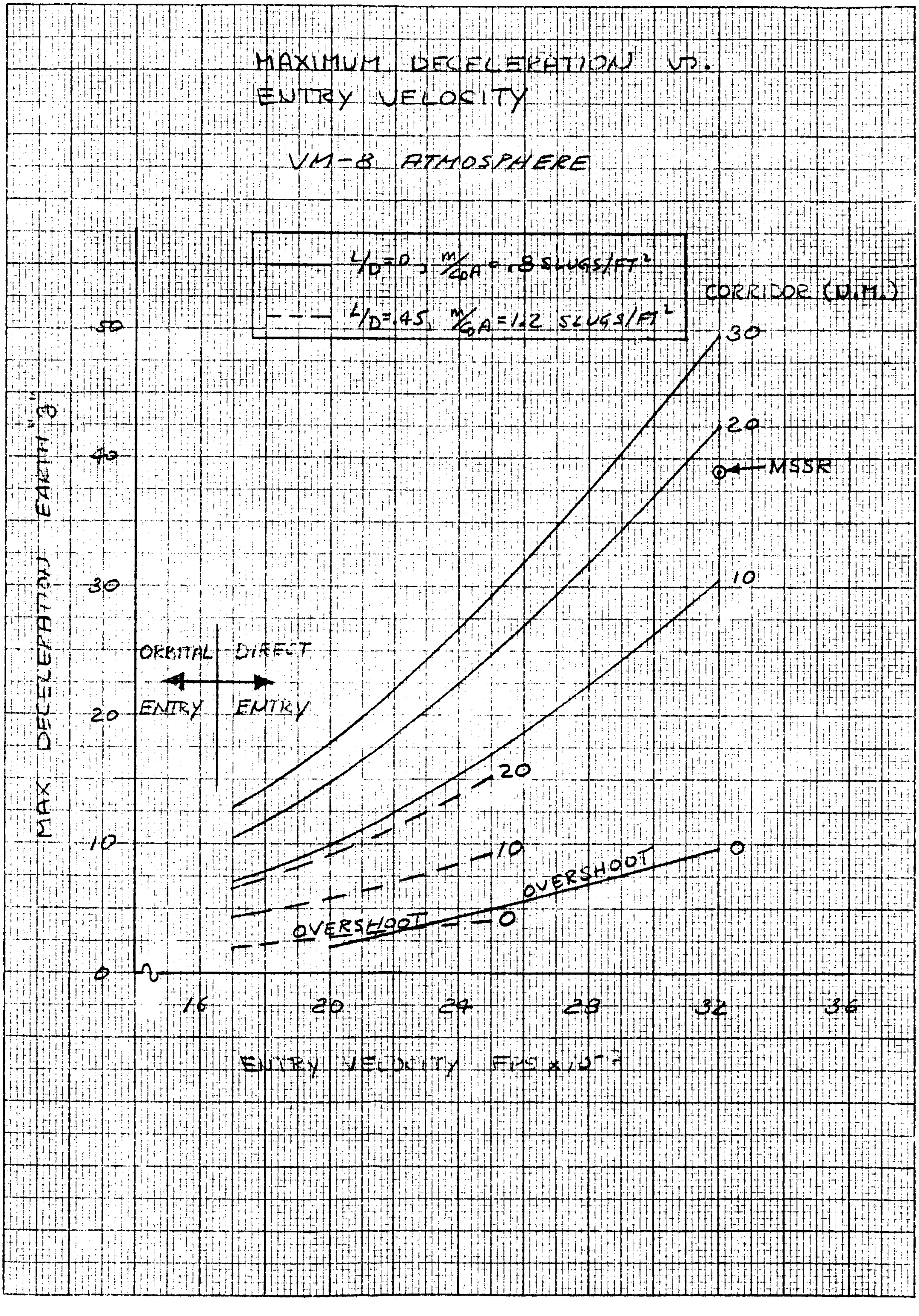
H. S. London

1013-DEC/HSL-pdm

Attachments
Figures 1 and 2



PAYLOAD VS. VELOCITY
15000 LB MSSR/MINIMEM
PAYLOAD, LBS
ASCENT ΔV, 10³ FPS
10
15
20
25
30
35
40
45
10000
1000
100
10
CIRCULAR ORBIT
ELLIPTICAL ORBIT
MARS TWILIGHT FLYBY
'75
'77
'79


MAXIMUM DECELERATION VS.
ENTRY VELOCITY
VM-8 ATMOSPHERE
L/D=0, m/CDA=.8 SLUGS/FT²
L/D=.45, m/CDA=1.2 SLUGS/FT²
CORRIDOR (N.M.)
30
20
10
0
MSSR
20
10
0
OVERSHOOT
OVERSHOOT
ORBITAL ENTRY
DIRECT ENTRY
MAX. DECELERATION EARTH "g"
0
10
20
30
40
50
16
20
24
28
32
36
ENTRY VELOCITY FPS x 10⁻³

BELLCOMM, INC.

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Case 103-2

From: D. E. Cassidy
H. S. London

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